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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/017,262	12/14/2001	David L. Adler	P960	6094

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EXAMINER	
JOHNSTON, PHILLIP A	
ART UNIT	**PAPER NUMBER**
2881	

DATE MAILED: 06/17/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

Office Action Summary	Application No.	Applicant(s)	
	10/017,262	ADLER ET AL.	
	Examiner	Art Unit	
	Phillip A Johnston	2881	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _14 April 2003_ .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _9-15,36-57,61,62 and 66-69_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _9-15,36-57,61,62 and 66-69_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _14 December 2001_ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

Detailed Action

Examiners Response to Arguments

1. Claims 9-15, 36-57, 61, 62, 66-69 as amended are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,317,514 to Reinhorn, in view of Todokoro, U.S. Patent No. 6,310,341, in further view of Ose, U.S. Publication No. 2001/0010357.

Regarding claims 9-15,36-40,43-51, and 57. Reinhorn (514) describes a method that comprises irradiating a spot of the wafer surface with a beam having a wavelength sufficiently shorter than the working function of the metal, such as deep UV beam, collecting the electrons released by the irradiated wafer, generating an electrical signal that is a function of the collected electrons, and inspecting the signal to determine whether any non-conductive material is present on said spot of the wafer, and particularly, if said spot comprises contact holes or vias, whether the contact holes or vias within the irradiated wafer spot are open. See Column 4, line 1-14.

It is implied herein that by selecting a light source that would excite photoelectrons from non-conductive materials and not excite metals, the method of the Reinhorn invention is equivalent to " increase the difference in photoelectron yield between at least two of said materials", as recited in Claims 11,37, and 43. It is also implied herein that the Reinhorn photon energy selection process is equivalent to

"identifying the chemical composition of said defect on the basis of the photon energy at which said photon yield increases substantially", as recited in Claim 57.

Although the Reinhorn (514) invention uses a DUV (deep ultraviolet) light source to generate photoemission from the wafer surface, where, it should be appreciated that other short wavelength light sources can be used. Specifically, laser light has been generally preferred because its spatial coherence ("polarized photons" as recited in Claims 14,15, 46 and 47) permits creating a small beam spot on the substrate. See Column 4, line 61-67, and Column 5, line 1-10. The light beam 24 is focused by objective 25 to form a spot on the wafer surface. Vacuum chamber 20 also contains an electron detector shown at 27, which has an opening for the passage of the light beam issuing from objective 25. Numeral 40 schematically indicates an optional biased electrode. It is preferable to have the light source 22 outside the vacuum chamber 20, and to allow the beam 24 to enter the chamber via window 28. Then the beam can be made to impinge upon the scanner 23. In operation, the beam is made to scan the wafer covering strips having a width determined by the scanning angle of the scanner 23 and length determined by the travel of the stage in a first direction, say in the Y direction.

It is implied herein, that the scanning angle of the Reinhorn (514) invention can be varied to include an angle of "90 degrees or less", as recited in Claims 12,13, 44 and 45.

Reinhorn (514) also discloses that once the beam completes scanning one strip, the stage moves in the second direction, say the X direction. As the light beam

impinges upon metal at the bottom of a contact hole or via, electrons are emitted and detected by the detector 27. On the other hand, if the contact hole or via is fully blocked, the energy of the impinging light beam would be insufficient to cause electron emission; so that an alarm can be issued that the contact hole is blocked or missing. Similarly, when the contact hole is partially blocked fewer electrons will be emitted, and a corresponding signal, provided by the detector 27 so that an alarm may be issued. The investigation of the signal can be done using methods such as a threshold, or any suitable algorithm for die-to-die, or a cell-to-cell comparisons, etc. In a similar manner, when inspecting the substrate for metal residue or similar defects, the wafer can be scanned to locate electron emission from areas where there should be only an insulator. For example, when the scan is performed in the trenches 130 of the insulator part 105, no electrons should be emitted. If electrons are emitted, it signals that there's metal residue inside on an insulating layer and a defect alarm should be issued. See Column 5; line 29-67, and Column 6, line-1-6.

Reinhorn (514) also teaches that when the electrons are pulled from the wafer, a positive potential may be left on the wafer. This phenomenon is known in the art as "charging effect". In order to avoid this charging effect, an electron gun is optionally placed in the vacuum chamber in order to direct electrons to areas that are already scanned in order to keep the wafer neutral, as recited in Claims 36 and 48. See Column 6, line 40-48.

Although Reinhorn (514) discloses, a wafer defect detection and classification method based upon irradiation with a photon source, Reinhorn (514) does not teach

the use of an imaging process in the method. Todokoro (341); however, discloses a projection type imaging method wherein an electron beam 116 accelerated by an electron gun 102 enters into a separator 104 through a lens 103 and a deflection system 110. A magnetic field H in a direction normal to the plane of the figure is applied to the separator 104. Therefore, the electron beam 116 is deflected, thereby, directed to a sample 101 through an objective lens 117. A negative voltage is applied to the sample. Therefore, the electron beam 116 is decelerated between the sample 101 and a cathode lens 115. By the deceleration, energy of the electron beam 116 with which the sample 101 is to be irradiated is adjusted below 100 eV. An electron beam 118, backscattered by the sample 101 is accelerated by the cathode lens 115, and enters in the separator 104 through the objective lens 117. Since the traveling direction of the electron beam 118 is opposite to that of the electron beam 116, the electron beam 118 is deflected to the direction opposite to the electron gun 102 by the separator 104. The deflected electron beam 118 is magnified by an intermediate lens 106 and a projective lens 107, and imaged on a surface of an MCP (a multichannel plate image intensifier) 108. The electron image amplified by the MCP 108 accelerated toward a fluorescent screen 109, to form on the fluorescent screen 109, the two-dimensional optical image is observed on an image tube 119. Although the above explanation is on the case where back-scattered electrons are imaged, it is possible to observe secondary electrons by irradiation electrons from an auxiliary electron gun 114 onto the sample 101 from an oblique direction and accelerating the generated secondary electrons using the cathode lens 115. In addition, numeral 112

designates a halogen lamp. When sample 101 is irradiated with the light from the halogen lamp it excites electrons, the "photoelectrons" as recited ion Claim 9, and the excited electrons are projected to form an image. See Column 3, line 9-45.

Todokoro (341) further discloses that an electron beam 118 back scattered by the sample 101 is accelerated by the cathode lens 115, and enters in the separator 104 through the objective lens 117. Since the traveling direction of the electron beam 118 is opposite to that of the electron beam 116, the electron beam 118 is deflected to the direction opposite to the electron gun 102 by the separator 104. The deflected electron beam 118 is magnified by an intermediate lens 106 and a projective lens 107, and imaged on a surface of an MCP (a multichannel plate image intensifier) 108. The electron image amplified by the MCP 108 accelerated toward a fluorescent screen 109 to form a on the fluorescent screen 109. The two-dimensional optical image is observed by being taken by an image tube 119. Adjustment of focusing is performed using the objective lens 117, and adjustment of magnification is performed using the intermediate lens 106 and the projective lens 107.

Although the above explanation is on the case where back-scattered electrons are imaged, it is possible to observe secondary electrons by irradiation electrons from an auxiliary electron gun 114 onto the sample 101 from an oblique direction and accelerating the generated secondary electrons using the cathode lens 115. Numeral 112 designates a halogen lump. The sample 101 is irradiated with the light from the halogen lump so as to excites electrons. The excited electrons are projected to form an image. See Column 3, line 19-45.

It is implied herein that the photon and electron sources of the Todokoro invention are utilized to "concurrently or alternately expose the substrate", as recited in Claims 38,39,49,and 50.

Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the wafer inspection method and apparatus of Reinhorn (514) with the imaging process of Todokoro (341) to provide an image of the wafer during the wafer inspection process. The resultant images of the surface would allow expanded defect detection capabilities in semiconductor manufacturing processes, particularly the identification of shape, location and composition of conductors and insulators relative to standards desired.

Regarding Claims 41,42, 52-56, 61,62, 66-69. Reinhorn in view of Todokoro, as applied to Claims 9-15,36-40,43-51, and 57 above discloses a method for imaging a substrate that includes nearly all the limitations of Claims 41,42, 52-56, 61, 62, 66-69, but does not disclose the use of angular dependent energy filtering as a means of discriminating between backscattered and photoemission electrons. Ose; however discloses an energy filter, based on the angle electrons are reflected and emitted from the substrate surface, that includes a cathode 4, which emits electrons when a beam voltage 6 is applied across the cathode 4 and an emission control electrode 5. The electrons thus emitted, are accelerated (decelerated in some cases) by emission control electrode 5 and an anode 8 held at a ground voltage. It is implied herein that the above described acceleration or deceleration capability of the Ose invention is equivalent to providing both " an influx of relatively high-energy, or low-energy electrons", as recited

in Claims 61,66 and 69. In addition, an acceleration voltage for accelerating a primary electron beam 1 is equal to an electron gun acceleration voltage 7. The primary electron beam 1, accelerated by the anode 8, is gathered by a condenser lens 9. A secondary electron detector, may be interposed between the energy filter 60 and the objective 10 to catch all the secondary electrons that collide against the meshes of the energy filter 60 and do not reach the conversion electrode 16. When there is not any retarding electric field or the retarding electric field is sufficiently small, only the reflected electrons pass the electron beam passing aperture of the objective 10. The reflected electrons have high energy. Positions at which the reflected electrons fall on the conversion electrode 16 are dependent on angle at which the electrons are reflected by the specimen 13 and energy of the reflected electrons. Therefore, information represented by the selected reflected electrons can be obtained in a high sensitivity by disposing an aperture filter 62 below the conversion electrode 16 with respect to the traveling direction of the primary electron beam. When the reflected electrons reflected in a substantially perpendicular direction are selected, an image of high contrast of a specimen having a specific atomic number can be observed in a high resolution. See Page 3, paragraph 0031, and 0032. It is implied herein, that the ability to utilize the angular dependent, energy filter method of Ose described above is equivalent to " selective detection of low-energy electrons, high-energy electrons, photoelectrons, reflected electrons, specular, and/or scattering effects" as recited in Claims 41,52-56, 61,62, and 66-69. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the wafer inspection method and

apparatus of Reinhorn in view of Todokoro as applied above, with the energy filter method of Ose, to provide improved resolution of surface topography as well as the ability to identify surface composition. In so doing, the Reinhorn in view of Todokoro, in further view of Ose, invention can be used to quickly define the shape and composition of wafer surface defects, resulting in more rapid identification of defect types, leading to faster resolution of quality, "root cause" issues, and a resulting higher semiconductor production throughput.

2. Applicant's arguments filed 4-14-2003 have been fully considered but they are not persuasive.

Argument 1.

Applicant states that "neither Reinhorn, nor Todokoro, nor the combination thereof, discloses or suggests the claimed "exposing a multi-pixel area of said wafer or said reticle to an influx of photons" and "focusing said photoelectrons to create an image of said wafer or said reticle in a plane of the detector." as recited in Claim 9. The applicant is respectfully directed to Todokoro (341), Column 3, line 19-45, which states; An <u>electron beam 118 back scattered by the sample 101</u> is accelerated by the cathode lens 115, and <u>enters in the separator 104 through the objective lens 117.</u> Since the traveling direction of the electron beam 118 is opposite to that of the electron beam 116, the electron beam 118 is deflected to the direction opposite to the electron gun 102 by the separator 104. The deflected <u>electron beam 118 is</u> magnified by an intermediate lens 106 and a projective lens 107, and <u>imaged</u>

on a surface of an MCP (a multichannel plate image intensifier) 108. The electron image amplified by the MCP 108 accelerated toward a fluorescent screen 109 to form a on the fluorescent screen 109. The two-dimensional optical image is observed by being taken by an image tube 119. Adjustment of focusing is performed using the objective lens 117, and adjustment of magnification is performed using the intermediate lens 106 and the projective lens 107.

Although the above explanation is on the case where back-scattered electrons are imaged, it is possible to observe secondary electrons by irradiation electrons from an auxiliary electron gun 114 onto the sample 101 from an oblique direction and accelerating the generated secondary electrons using the cathode lens 115. Numeral 112 designates a halogen lump. The sample 101 is irradiated with the light from the halogen lump so as to excites electrons. The excited electrons are projected to form an image.

The examiner has interpreted from the Todokoro (341) reference above that electrons generated at the surface of the sample by either an electron beam or a photon beam enter the energy selector through an objective lens 117, which is used to focus the electrons onto an MCP detector.

Argument 2.

The applicant states that "In addition, claim 36 further distinguishes over the combination of Reinhorn and Todokoro by "exposing said area of said substrate to an influx of electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined

level." Reinhorn briefly mentions an electron gun, but Reinhorn relates to a spot scanning system where maintaining surface charge would be problematic due to the highly concentrated nature of the electron loss near the spot. In contrast, the claimed invention exposes a multi-pixel area and so has more evenly distributed electron loss that is more effectively compensated using such an exposure to electrons."

The applicant is also respectfully directed to Todokoro (341), Column 4, line 42-54, which states; The irradiated electron beam 216 has an acceleration voltage of 11 kV, and after passing through the first projective lens 295 and the objective lens 203 the irradiated electron beam 216 is decelerated to an acceleration voltage of 1 kV by the negative voltage of 10 kV applied to the sample 201. When the acceleration voltage of the irradiated electron beam 216 is 1 kV, the sample 201 can be observed without being charged even if the sample is an insulation substance such as a semiconductor.

The examiner has interpreted from the Todokoro (341) reference above, that by insuring that the electron beam energy is striking the sample is 1kV, in accordance with Todokoro (341), the energy of the electrons has been selected to "maintain surface charge present on the substrate at a predetermined level", as recited in Claim 36.

Argument's 3 and 4.

The applicant states that," Like claim 36, claim 48 relates to exposing a substrate to both an influx of photons and an influx of electrons. Unlike claim 36, claim 48 relates to a method where the reflected electrons (rather than the photoelectrons)

are imaged. Applicants respectfully submit that the method of claim 48 is patentably distinct over the combination of Reinhorn, Todokoro, and Ose."

The applicant also states that, "Like claim 36, claim 55 relates to exposing a substrate to both an influx of photons and an influx of electrons. Beyond claim 36, claim 55 relates to a method where both the reflected electrons and the photoelectrons are imaged. Applicants respectfully submit that the method of claim 55 is patentably distinct over Reinhorn, Todokoro, or Ose, or the combination thereof. In particular, Ose does not disclose or suggest such imaging of both reflected electrons and photoelectrons."

The applicant is respectfully directed to the Todokoro (341) references above, which describe the exposure of the sample with both electrons and photons and the imaging of both reflected and photoelectrons.

Argument 5.

The applicant states that, "Regarding Ose, the acceleration or deceleration capability in the electron gun of Ose relates to varying the energy of a relatively high-energy electron beam; it does not provide an influx of relatively low-energy electrons for surface charge maintenance as recited in limitation b). Moreover, Ose does not disclose or suggest c) filtering to select the secondary electrons while rejecting the reflected low-energy electrons. Hence, applicants respectfully submit that the method of claim 61 is patentable over the combination of Reinhorn, Todokoro, and Ose.

The applicant is respectfully directed to the Todokoro (341) references above, and to the Abstract in Todokoro (341), which states; only the secondary electrons having a specified energy pass through energy selecting aperture, and further pass through a second projective lens to form a projected image of the secondary electrons on an imager. Such an electron-optical system may be used for dimension evaluation or inspection of semiconductor substrates.

The examiner has interpreted from the Todokoro (341) reference above, that by insuring that the electron beam energy striking the sample is 1kV, so that the sample can be observed without being charged, is equivalent to "the energy of the electrons has been selected to maintain surface charge present on the substrate at a predetermined level", as recited in limitation b) of Claim 61.

The examiner has also interpreted from the Todokoro (341) reference above, that by having a specified energy pass through an energy selecting aperture is equivalent to "filtering is applied to select the secondary electrons while rejecting the reflected low-energy electrons", as recited in limitation c) of Claim 61.

Argument 6.

The applicant states that, "Like claim 61, claim 66 relates to exposing a substrate both to a) an influx of relatively high-energy electrons to cause secondary electron emission and to b) an influx of relatively low-energy electrons to maintain surface charge. In contrast to claim 61, claim 66 applies c) filtering to select the reflected low-energy electrons while rejecting the secondary electrons, and d) focuses the reflected electrons to create an image in a plane of the detector. In other words, claim

fib isolates detection of reflected low-energy electrons while claim 61 isolates detection of secondary electrons. Regarding Ose, the acceleration or deceleration capability in the electron gun of Ose relates to varying the energy of a relatively high-energy electron beam; it does not provide an influx of relatively low-energy electrons for surface charge maintenance as recited in limitation b). In addition, Ose does not disclose or suggest c) filtering to select the reflected low-energy electrons while rejecting the secondary electrons. Hence, applicants respectfully submit that the method of claim 66 is patentable over the combination of Reinhorn, Todokoro, and Ose."

The applicant is respectfully directed to the Todokoro (314) references above regarding exposure of the sample to a decelerated 1 kV electron beam.

The examiner has interpreted from the Todokoro (341) reference above, that insuring that the electron beam energy striking the sample is 1kV, so that the sample can be observed without being charged, is equivalent to "provide an influx of relatively low-energy electrons for surface charge maintenance", as recited in limitation b) of Claim 66.

Argument 7.

The applicant states that, "Like claims 61 and 66, claim 69 relates to exposing a substrate both to a) an influx of relatively high-energy electrons to cause secondary electron emission and to b) an influx of relatively low-energy electrons to maintain surface charge. Regarding Ose, the acceleration or deceleration capability in the electron gun of Ose relates to varying the energy of a relatively high-energy electron

beam; it does not provide an influx of relatively low-energy electrons for surface charge maintenance as recited in limitation b). Furthermore, Ose does not disclose or suggest c) filtering to select nonperpendicular secondary electrons and reflected electrons away from the specular angle, nor does Ose disclose or suggest d) focusing the selected electrons to create an image of said substrate in the plane of a detector. Hence, applicants respectfully submit that the method of claim 69 is patentable over the combination of Reinhorn, Todokoro, and Ose.

The applicant is respectfully directed to the Todokoro (314)' which states; The deflector 229 is used for adjusting the secondary electron beam 218 so as to coincide with the axis of the first projective lens 205. The deflector 231 is also used for adjusting the secondary electron beam 218 passed through the energy filter 207 so as to coincide with the axis of the second projective lens 209. The positional relationship of the energy selecting aperture 208 and the deflector 231 may be reversed. Further, the deflector 230 is for adjusting the image-taking position of a projected image, and is used for automatic adjustment of a position to be inspected and observed.

The examiner has interpreted from the Todokoro (341) reference above, that adjusting the secondary electron beam with deflectors 229 and 231 to make the beam coincide with the axis of the projective lens before and after passage through the energy filter 207 is equivalent to "select nonperpendicular secondary electrons and reflected electrons away from the specular angle", as recited in limitation c) of Claim 69.

Conclusion

3. The Amendment filed on 4-14-2003 under 37 CFR 1.131 has been considered but is ineffective to overcome the Reinhorn (514), Todokoro (341) and Ose (357) references.

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Phillip A Johnston whose telephone number is 305 7022. The examiner can normally be reached on 7:30 to 4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John R Lee can be reached on 703 308 4116. The fax phone numbers for the organization where this application or proceeding is assigned are 703 872 9318 for regular communications and 703 872 9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703 308 0956.

PJ
June 9, 2003

JOHN R. LEE
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800